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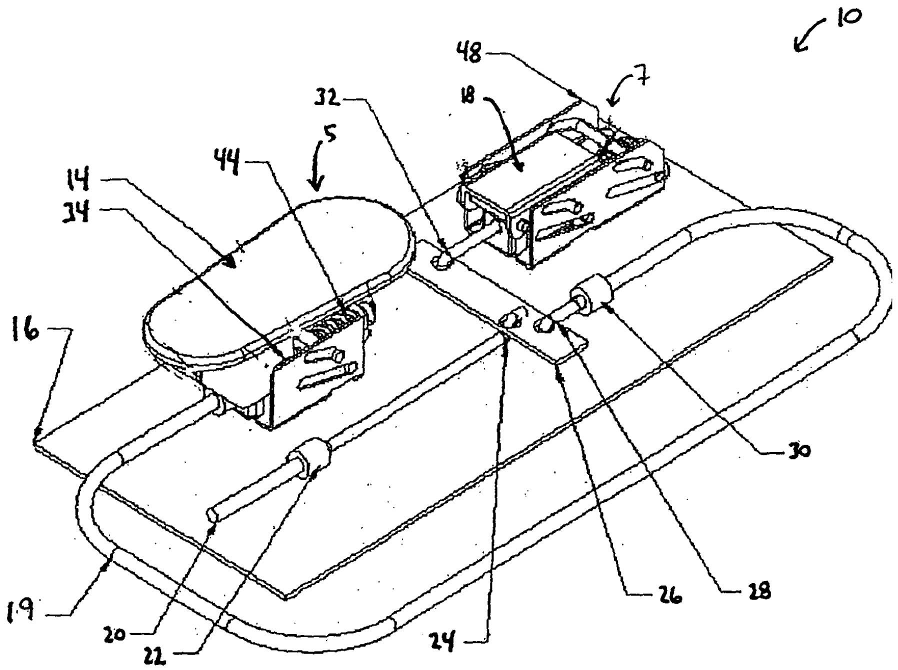
(54) **Seat with adjustable support system**

(57) A sacral support assembly for use with a seat is provided. The seat includes a seat frame. An adjustable sacral support assembly (5) is connected to the seat frame. The sacral support assembly (5) includes a sacral support member (14) adapted to support the sacrum of a seated user even when an obstruction is located between the user and the sacral support assembly. A method is also provided for delivering primary support to a user's sacrum and sacral-pelvic anatomy and secondary support (7) to the remaining regions of the spine and/or adjacent anatomy to reduce fatigue, increase comfort, structural balance, stability, and posture control for a user, and a system for adjusting and controlling the load distribution from the sacral anatomy to the spine and other anatomical structures adjacent to a user's sacrum, for example, the pelvis, lumbar, thoracic and cervical regions.




(FIG. 1)

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## Description

## FIELD OF THE INVENTION

**[0001]** The present disclosure relates generally to a seat having an adjustable support system for controlling the posture and/or balance of a seated person.

## BACKGROUND

**[0002]** Many people in modem society spend extended amounts of time seated at work, school, home, and/or while traveling. Millions of people sit during lengthy commutes to and from work. Once at work, they sit continuously in an office chair for numerous hours. Additionally, many occupations require spending much of the day seated in an automobile. For example police officers, truck drivers, and taxi cab drivers, have jobs that require spending much of the day seated in an automobile. Similarly, airplane pilots spend much of the day seated in airplane seats.

**[0003]** For the most part, seats have several elements in common. They have a bottom portion, or seat pan, which receives the bulk of a user's weight, and a seatback, against which a user reclines. As relates to the seatback, a wide variety of mechanisms have been developed that purportedly provide back support for a user. Nevertheless millions of people continue to suffer from chronic and severe back pain caused by sitting for extended amounts of time. This is because conventional seatbacks have yet to provide back support that proactively resolve the medical causes of back pain, rather than the symptoms of back pain.

**[0004]** By way of background, the spine has four regions: cervical (neck), thoracic (upper back), lumbar (lower back), and sacral (tail bone). The sacrum is a large triangular fusion of five vertebrae that forms the base of the spine. The sacrum is located between the pelvic bones, which include the left and right ilium. The ilia each have a posterior border portion known as the posterior superior iliac spine ("PSIS"). The lumbar region includes the five vertebrae located above the sacrum, the thoracic region includes the twelve vertebrae located above the lumbar region, and the cervical region includes the seven vertebrae located above the thoracic region. Each region of the spine transitions into the adjacent region(s). For example, there is a thoracic-lumbar transition extending between thoracic vertebra 12 (T12) and lumbar vertebra 1 (L1).

**[0005]** As viewed from the side, the spine of a person with good posture forms a rearward curve known as the thoracic or kyphotic curve, and two forward projecting curves known as the lumbar or lordotic curve and the cervical curve. When taken together, these three curves form an S-shaped portion of the spine. This S-shape provides a great deal of strength, stability, flexibility, and endurance because the body primarily relies on the skeletal structures (i.e., the vertebrae) to support the weight of a persons body, rather than primarily relying on the musculature for support.

**[0006]** Relating to a user's posture, conventional seats have a number of shortcomings. First, conventional seats cause a user's spine to collapse from an S-shape into a C-shape. This collapse occurs because of improper back support. Stated differently, conventional seats lack strategically located support. Without strategically located support, the sacrum tilts rearward, and causes the spine to assume a C-shape, When the spine is in a C-shape, the user primarily relies on the musculature for support rather than skeletal structures. Sitting with the spine in a C-shape and over-relying on the musculature for support can lead to a number of immediate problems, for example, increased fatigue, increased pressure on the lumbar discs, or the creation of muscle stresses, strains, and spasms. Moreover, various long-term problems can also occur. These problems include pain in the lower back muscles, discomfort between the shoulder blades, tightening of neck muscles and muscle soreness and headaches.

**[0007]** A second problem is that conventional seats lack a contoured surface match between the surface of the seat and the surface of a user's anatomy. For example, conventional seats lack a proper nesting or receiving portion for the PSIS. In particular, the seat back pressures the PSIS. This can lead to poor posture, which often results in varying degrees of discomfort and back or spine problems. Forth, conventional seats provide poor distribution of the load forces experienced by the user.

**[0008]** Somewhat recently, it has been recognized that a spinal support device for applying a directed and concentrated force on the sacrum to properly position the pelvis and spine of a user could be constructed. In U.S. Patent No. 6,125,851 ("the '851 patent"), a spinal support device is disclosed that helps support the sacrum of a user to induce the spine to take the preferable shape found in a normal standing posture.

**[0009]** While the '851 patent in part addresses the void created by seats around the sacral region, there still exists an urgent need to implement proper sacral support.integrated within seatbacks, such as those used in residential seating, office seating, and/or vehicular seating. In particular, there exists a need to provide proper sacral support in a system that is integral to a seatback and adjusts according to the preferences of a variety of users that differ from each other in proportion and size. In addition, there exists a need to provide improved load distribution across the surrounding pelvic area, especially around the PSIS.

**[0010]** A full support system is also urgently needed, including proper primary sacral support combined with secondary or complementary support for other regions of the spine. Moreover, proper sacral support is urgently needed by persons that have obstructions between their backs and the seatbacks. For example; police officers often wear a belt with a handcuff wallet. The handcuff wallet forms a bulge or obstruction that makes sitting with good posture particularly difficult. Similarly, military personnel wear various body armors, and construction workers often wear bulky tool belts that can cause the spine to shift out of proper alignment when the worker is in a seated position.

## SUMMARY OF THE INVENTION

**[0011]** The present invention is directed to an improved seat. According to a first aspect of the present invention, the improved seat delivers adjustable, specific, stabilizing support, and contoured fit to a user's sacrum and sacral-pelvic anatomy, while allowing the user to wear a waist pack, a belt having a handcuff wallet, body armor, a tool belt, or other obstruction. The improved seat effects changes in a user's sacral anatomy that result in user efficiency, strength, and muscle control. The improved seat actively targets and controls specific portions of the sacrum, thereby increasing the comfort, endurance, and stability of a user. This is accomplished in an adjustable, convenient maimer for users who differ from each other in proportion and size. Furthermore, the improved seat provides anatomically contoured fit by offering a surface match between the contours of a user's anatomy and the seatback.

**[0012]** According to a second aspect of the present invention, a sacral support assembly for use with a seat is provided. The sacral support assembly provides a support mechanism that primarily supports the sacrum and sacral-pelvic anatomy, while providing secondary or complementary support for one or more of the remaining regions of the spine.

**[0013]** As used herein the term "connected to" is intended to be interpreted broadly and to include direct and indirect connections.

**[0014]** As used herein the term "vehicle" is intended to be interpreted as broadly including transportation-related applications in general, for example, automobiles, airplanes, boats, trains, wheelchairs, etc.

**[0015]** These and other features, aspects, and advantages of the present invention will become better understood with reference to the following description, appended claims, and accompanying drawings where:

## BRIEF DESCRIPION OF THE DRAWINGS

**[0016]** Figure 1 is a front perspective view of an adjustable support system including a retracted sacral support and a retracted thoracic-lumbar support;

**[0017]** Figure 2 is a side view of an adjustable support system including a sacral support and a thoracic-lumbar support;

**[0018]** Figure 3 is a front perspective view of an adjustable support system including a sacral support in an extended position and a thoracic-lumbar support in an extended position;

**[0019]** Figure 4 is a side view of an adjustable support system including a sacral support in an extended position and a thoracic-lumbar support in an extended position;

**[0020]** Figure 5 is a front perspective view of an adjustable support system including a sacral support in an extended position and a thoracic-lumbar support in a partially extended position;

**[0021]** Figure 6 is a side view of an adjustable support system including a sacral support in an extended position and a thoracic-lumbar support in a partially extended position;

**[0022]** Figure 7 is an exploded view of a sacral support;

**[0023]** Figure 8 is an exploded view of a complementary support;

**[0024]** Figure 9 is a front perspective view of a sacral support in an extended position;

**[0025]** Figure 10 is a front perspective view of a sacral support in a retracted position;

**[0026]** Figure 11 is a side view of a sacral support in a retracted position;

**[0027]** Figure 12 is a front perspective view of a sacral support in a retracted and tilted position;

**[0028]** Figure 13 is a front perspective view of a seat having a sacral support and a thoracic-lumbar support;

**[0029]** Figure 14 is a front perspective view of a seat having a sacral support, a thoracic-lumbar support, and a load distribution material;

**[0030]** Figure 15 is a front perspective view of a seat having a sacral support, a thoracic-lumbar support, and a load distribution material;

**[0031]** Figure 16 is a front perspective view of a seat having a sacral support, a thoracic-lumbar support, and a load distribution material;

**[0032]** Figure 17 is a front perspective view of a seat having a sacral support, a thoracic-lumbar support, and a load distribution material; .

**[0033]** Figure 18 is a rear sectional view of a load distribution material for use with a sacral support system;

**[0034]** Figure 19 is a rear sectional view of a load distribution material for use with a sacral support system;

**[0035]** Figure 20 is a rear sectional view of a load distribution material for use with a sacral support system;

**[0036]** Figure 21 is a rear sectional view of a load distribution material for use with a sacral support system;

**[0037]** Figure 22 is a side sectional view of an adjustable support system including a sacral support in a retracted position and a complementary support in a retracted position;

**[0038]** Figure 23 is a front perspective view of an adjustable support system including a sacral support in a retracted position and a complementary support in a retracted position;

**[0039]** Figure 24 is a side sectional view of an adjustable support system including a sacral support in an extended position and a complementary support in an extended position;

**[0040]** Figure 25 is a front perspective view of an adjustable support system including a sacral support in an extended position and a complementary support in an extended position; and

**[0041]** Figure 26 is an exploded view of an adjustable support system including a sacral support and a complementary support.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0042]** The invention is described with reference to the drawings in which like elements are referred to by like numerals. The relationship and functioning of the various elements of this invention are better understood by the following detailed description. However, the embodiments of this invention as described below are by way of example only, and the invention is not limited to the embodiments illustrated in the drawings. It should also be understood that the drawings are not to scale and in certain instances details have been omitted, which are not necessary for an understanding of the present invention, such as conventional details of fabrication and assembly. Moreover, it should be noted that the invention described herein includes methodologies that have a wide variety of applications, including, for example, office, residential, and commercial seating applications.

**[0043]** Referring to the drawings, Figure 1 illustrates an embodiment of the present invention, and particularly, an adjustable support system having a sacral support system and a complementary support system. The adjustable support system can control the position of the user's sacral-pelvic region, thoracic-lumbar area, mid and upper thoracic area, or a wide variety of other parts of a user's back. Such support ultimately can be used to control the user's overall seated posture.

**[0044]** In general, the sacral support system includes a sacral support member that is configured to tilt vertically along a plane formed by the seatback. This allows a user wearing a utility belt, a waist pack, a handcuff wallet, body armor, or other obstructive element (even as small as a belt loop), to contact the sacral support without creating an uncomfortable pressure zone around the user's sacral area. The tilt feature thus allows the seatback to comfortably accommodate or nest an obstructive element without sacrificing comfort or sacral support. The sacral support system also includes a delivery mechanism that a user can use to adjust the amount of sacral support delivered by the sacral support system.

**[0045]** The sacral support system can be used either alone or in cooperation with complementary support system. In general, the complementary support system includes a support member and a delivery mechanism that is controlled by the user. The complementary support can be positioned within the seatback at a wide variety of positions that correspond with different areas of a user's back. For example, the complementary support system can be located within the seatback at a position corresponding with the thoracic-lumbar transition or the upper thoracic region of a user. The sacral support system and the complementary support system are each discussed in detail as follows.

**[0046]** Referring to Figure 1, sacral support system **5** includes a sacral support member **14**, which is located within the seatback at a position that corresponds with the sacrum and sacral-pelvic anatomy of a user. The sacral support member is engineered to support the sacrum and sacral-pelvic anatomy of a user. The sacral support member preferably is formed of a substantially rigid material, such as steel, plastics, or carbon fiber, but materials providing a similar level of support can also be used. Sacral support member **14** is generally flat, pear-shaped, and oriented with a larger width at a top portion and a smaller width at a bottom portion. This shape and orientation coincides with the shape and orientation of the sacrum of a user. More specifically, an upper portion of sacral support member **14** has a horizontal width of approximately 3.25 inches. A lower portion of sacral support member **14** has a horizontal width of approximately 2.6 inches.
Preferably, the vertical length of sacral support member **14** is approximately 5.25 inches.

**[0047]** The top width of sacral support member **14** can vary from 3 times the width of the sacrum of a user at the level of the sacral base of the user to approximately equal to the width of the sacrum of a user at the level of the sacral base of the user. The width of sacral support member **14** decreases progressively from a top portion to a bottom portion of sacral support member **14.** The width of the bottom portion is approximately greater than or equal to the width of the sacrum of a user at a level corresponding with the bottom portion. However, as discussed below, the dimensions of the sacral support member **14** may vary depending on a variety of factors.

**[0048]** Since sacral support member **14** is preferably rigid and mainly supports the sacrum, it is preferable to provide a load distribution material between sacral support member **14** and the sacrum of a user, as illustrated in Figures 14-17. For example, as illustrated in Figure 15, load distribution material **98** provides a surface that adjusts to the contours of the sacrum and sacral-pelvic area of a user. Alternatively, as illustrated in Figure 18, load distribution material **98** provides a contoured, nesting area for the PSIS's of the ilias. Other preferred arrangements and designs of the load distribution material are illustrated in Figures 14-17 and 18-21. For example, Figure 19 illustrates an embodiment in which the load distribution material **102** is partially butterfly-shaped. Figure 20 illustrates and embodiment in which two load distribution materials, **104** and **106,** are provided. Figure 21 illustrates a load distribution material **109** designed to generally cover the anatomical surfaces of the sacral-pelvic area, while also avoiding the PSIS's of the ilias.

**[0049]** In use, when sacral support member **14** is in an engaged position, the load distribution material improves load distribution across soft tissues of the sacral area of the user and avoids localized pressure on the PSIS's of the ilias. Preferably, conventional support materials may be used to provide load distribution, such as compressed foams, plastics or strips of lightweight metals, for example aluminum. The size and shape of the load distribution material may be altered to accommodate the user's specific anatomical contours and provide improved support and fit. The size and shape of the load distribution can also be altered depending on the particular seat trim package. For example, bucket type seats configured for racing applications can be outfitted with relatively rigid load distribution materials, so as to provide greater support and load distribution.

**[0050]** In addition, cushioning is preferably provided between the user, the front portion of the seatback and load distribution material. The cushioning may be formed of conventional cushioning materials such as foam. Accordingly, in a preferred embodiment, a front portion of the seatback is followed by a cushioning, which is followed by a load distribution material, which is followed by sacral support member **14.** Alternatively, a load distribution material can be provided between the front portion of the seatback and the cushioning.

**[0051]** It should be understood that the amount of load distribution material, cushioning, and the dimensions of the sacral support member are related, and can be altered while still achieving the desirable levels of sacral support and contoured fit. For example, to some extent, a sacral support member having smaller dimensions than discussed above may be used if a relatively large load distribution material or cushion is provided between the sacral support member and the user. Conversely, a larger sacral support member than suggested above may be used if relatively less cushioning and load distribution material is provided between the sacral support member and the user. Also, the sacral support member, the load distribution material and cushion may be formed of a unitary structure while still achieving the preferred results of sacral support and contoured fit. Similarly, the load distribution material can be attached directly to the sacral support member.

**[0052]** When the sacral support is in an engaged position, sacral support member **14** extends approximately between 1.5 inches and 3 inches forward with respect to a plane created by the seatback. It has been discovered that delivering sacral support member **14** a distance greater than about 3 inches forward of the plane created by the seatback is unnecessary. One embodiment of sacral support system shown in Figures 1-6 and 9-12 is designed to deliver sacral support member **14** up to 1.25 inches forward of the plane created by the seatback. Notwithstanding this, alternative embodiments of the present invention may deliver sacral support member **14** a maximum distance up to or greater than 3 inches forward of the plane created by a user's back, or a maximum distance less than 3 inches forward of the plane created by a user's back, as described in detail below.

**[0053]** The overall distance of travel of sacral support member **14** toward the user depends on a variety of factors. For example, the overall distance of travel of sacral support member **14** may change depending on the location where the sacral support system is mounted within a seat frame, the size of the seat frame, the type of material used to cover the seat, and the thickness of any cushioning and load distribution material that may be located between the seat cover and sacral support member.

**[0054]** In addition to sacral support member **14,** sacral support system **5** includes a delivery mechanism having pitch poles 3**4,** cam profile channel **38,** parallel bar **40,** compression spring **44** and actuator cable **28,** as illustrated in Figure 7. When used as a stand-alone unit, i.e., without a complementary support system, the sacral support system is attached to the seatback frame. As will become apparent to one of ordinary skill in the art, the cam profile channel 38 can be secured to the seatback frame, for example, by welding. Alternatively, when used in combination with a complementary support system, the sacral support system can be secured to base plate 16, as shown in Figure 1. In turn, base plate 16 is secured to the seat frame.

**[0055]** The delivery mechanism for adjusting the position of sacral support member **14** is illustrated in Figures 9-10. In particular, pin **55** is inserted through holes in pitch poles **34** and support base **36** so as to pivotally connect pitch poles **34** to support base **36.** This connection allows the support base to tilt relative to the pitch poles. A wide variety of alternative mechanisms for attaching the pitch poles to the support base will become readily apparent to one of ordinary skill, for example, a ball and socket connection.

**[0056]** As shown in Figure 9, pin **54** is inserted through holes in pitch poles **34** and is used to slidably connect pitch poles **34** to cam profile channel 38. The ends of pin **54** form cams that slide along the upper cam profiles **62** in cam profile channel **38**. In addition, pegs **56** are inserted into peg holes in pitch poles **34** and parallel bar **40.** Each peg **56** provides a cam surface that slides along lower cam profile **64** in cam profile channel **38**. Since the parallel bar is connected to both pitch poles, the pitch poles travel in tandem along the path created by cam profiles **62** and **64.** As illustrated in Figures 9-10, the geometry of cam profiles **62** and **64** define the path along which the sacral support member ultimately travels. Accordingly, the geometry of cam profiles **62** and **64** can be altered to change the path along which the sacral support member travels. For example, cam profiles **62** and **64** can be configured so that the sacral support member initially travels in a first direction and subsequently in a second direction.

**[0057]** As illustrated in Figures 9 and 10, in operation, a user determines the amount of desired sacral support and then operates the sacral support system to alter the position of the sacral support member. In a disengaged position sacral support member **14** provides minimal or no support to a user's sacrum or sacral area. As desired, a user may adjust the position sacral support member **14** toward the user's sacrum to provide increased support. In particular, when the sacral support system is used as a stand-alone support system (i.e., without a complementary support system), a standard take-up **motor 99** can be used to control the position of the sacral support member relative to a user.

**[0058]** As take-up motor retracts actuator cable **28,** the end of actuator cable **28** that is adjacent to spring **44** causes spring **44** to compress against parallel bar **40.** As the energy stored in spring **44** increases, spring **44** eventually forces parallel bar **40** to move pitch poles **34**. Consequently, sacral support member **14** travels toward the user's sacral area as desired by the user. Conversely, the take-up motor can be operated to let out actuator cable **28,** thereby returning the sacral support member to a retracted position. Spring 44 and pressure from the seatback and cushioning material assist in returning the sacral support member to a fully retracted position.

**[0059]** When the sacral support system is in a fully or partly extended position, spring **44** forms a spring suspension. In particular, as a user reclines against the engaged sacral support member, the user's sacrum creates a rearward force on sacral support member. This force is distributed to pitch poles **34**, causing pitch poles **34** to rotate counter-clockwise. As pitch poles **34** rotate, sacral support member **14** tilts backward at an angle that substantially coincides with the tilt of a user's sacrum. As a result, sacral support member **14** automatically adjusts to the natural tilt of a user's sacrum, while simultaneously providing an adjustable supporting force. In addition, spring **44** continually urges the sacral support member towards a user, thereby providing continuous support, even as the user shifts between wide varieties of seated positions. The adjustable supporting force can be tailored by changing the size or stiffness of the compression spring, as required by various seating environments.

**[0060]** As stated above, sacral support system **5** can be used in cooperation with complementary support system **7.** Complementary support system **7** can be located at a wide variety of positions within the seatback so as to correspond with various targeted areas of the spine or adjacent anatomical structures of a user. For example, complementary support **7** can be located within the seatback at a position that allows a user to control fit, comfort and posture. In one such example, complementary support **7** can be located within the seatback at a level corresponding with a user's spine at the area between about thoracic vertebra 12 and lumbar vertebra 1. Alternatively, complementary support **7** can be located within the seatback at a position corresponding with the scapulae or paravertebral muscles of a user. Likewise, complementary support 7 can be located within the seatback so as to provide improved fit, comfort, and posture control by improving the contoured surface contacts between the user's anatomy and the seating surface.

**[0061]** As illustrated in Figure 8, complementary support **7** includes a support member **18**, pitch poles **46,** parallel bars **50,** and a pull cable assembly **32.** Support member **18** can be formed of a rigid material, as described above relative to the sacral support member. Support member **18** is shaped to correspond with a targeted region of the back. For example, as shown in Figures 1-6 and 8, support member **18** is rectangular, so as to provide support to the thoracic-lumbar transition of a user's spine. Figures 13-17 illustrate the location of support member **18** relative to the seatback and seat frame **4**. In particular, Figures 13-17 illustrate support member **18** positioned within the seatback at a location that corresponds with the thoracic-lumbar transition of a user's spine.

**[0062]** The support member of the complementary support system can also be provided with a load distribution material as described above relative to sacral support member 14. Figures 15-17 provide various shapes in which a load distribution material **98** can be provided within a seatback. Additionally, a cushioning material as described above is also provided between the user and the support member **18**.

**[0063]** Referring to Figure 6, support member **18** is pivotally connected by pegs **60** to pitch poles **46.** Pitch poles **46,** are slidably positioned within the walls of cam profile channel **48,** which is secured to base plate **16.** In general, the pitch poles are configured so that an end of the pitch poles travels away from the cam profile channel and toward a user's back. To achieve this, pins **58** are inserted into holes in pitch poles **46** and positioned within cam profiles **70** and **72.** In addition, parallel bars **50** connect pitch poles **46.** Parallel bars **50** are rotatably secured to pitch poles **46** by pins **60.** Parallel bars **50** force the pitch poles to move simultaneously relative to cam profile channel **48**. Because pins **58** track cam profiles **70** and **72,** the free ends of the pitch poles travel in a relatively linear path away from the cam profile channel. As a result, support member 18 is urged towards the targeted portion of the user's back.

**[0064]** Referring to Figure 8, a drive system is used to deliver the complementary support member. The illustrative drive system includes a complementary support actuator **32**, a cable guide **74**, a cross-bar **76** connected to parallel bars **50**, a compression spring **52,** and a spring cap **53.** Complementary support actuator **32** is disposed axially through spring **52** and the center hole provided in cross-bar **76**. Spring cap **53** secures complementary support actuator to spring **52**. As such, when complementary support actuator **32** is pulled through cable guide **74,** pressure builds between spring **52** and cross-bar **76.** When the force stored in spring **52** exceeds the outside pressure applied by the seatback, parallel bars **50** begin to move toward cable guide **74**. As a result, support member **18** moves toward the user's back.

**[0065]** Referring to Figures 1-6, sacral support system **5** and complementary support system **7** are used in combination to provide both sacral support and thoracic-lumbar support. The adjustable support system can deliver support in a variety of configurations, which can be controlled by the user. For example, Figures 1 and 2 illustrate a first embodiment of the present invention in which the sacral support member **14** and the complementary support member **18** are both retracted. Figures 3 and 4 illustrate sacral support member **14** and complementary support member **18** fully extended. Figures 5 and 6 illustrate sacral support member **14** fully extended and complementary support member **18** partly extended.

**[0066]** As illustrated in Figures 1-6, the adjustable support system can be configured so that a single control unit synchronously controls the position of both the sacral support system and the complementary support system. As shown in Figure 3, actuator cables **24, 28,** and **32** are connected to lever **26.** When the main actuator cable **24** is retracted, lever **26** travels downward relative to the seatback.

As a result, actuators **28** and **32** are retracted, thus effecting delivery of sacral support member **14** and support member **18**. The ratio of sacral support to complementary support is adjustable. This ratio can be adjusted by changing the position where the actuator cables are attached to lever **26**. As such, the adjustable support system can be configured so that the sacral support travels farther toward a user than the complementary support, thereby providing a greater level of specific support and comfort.

**[0067]** In addition, the adjustable support system of Figures 1-6 includes a suspension. In use, pressure applied to the sacral support by a user's sacrum is counterbalanced by pressure applied to the complementary support by a user's thoracic-lumbar area. Moreover, springs **44** and **52** provide additional comfort by at least partly absorbing rearward forces created, for example, when a user changes positions in the seat; drives over uneven terrain, or encounters turbulence, depending on the application in which the adjustable support system is used. The stiffness of the spring suspension can be changed by using either stiffer or less stiff springs **44** and **52,** or by eliminating springs **44** and **52** altogether.

**[0068]** Adjustable support system **10** can be controlled by a conventional electric take-up motor or manually. A conventional rotary cam drive can facilitate manual operation. Other suitable drive systems include worm drives, and chain drives. Indeed, many alternate drive systems that can effect movement of an actuator cable or lever can be used to control the adjustable support system **10.** Moreover, it should be noted that the sacral support system can be configured to function synchronously or independently of complementary support system.

**[0069]** Referring to Figures 22-26, a second embodiment of an adjustable support system **10** is shown, including sacral support system **5** and complementary support system **7.** Adjustable support system **10** is configured to deliver sacral support member **14** and complementary support **18** a distance of 3 inches or more toward a user. Sacral support member **14** is configured as described above with respect to the previous embodiment. Complementary support member **18** is formed from a rigid, rectangular block, as illustrated in Figure **22**.

**[0070]** As illustrated in Figure 26, similar delivery mechanisms are used to deliver the sacral support member and the complementary member. Sacral support system **5** includes lift arms **129**, cantilever arms **131,** and sacral support actuator cable 133. As illustrated in Figure 24, lift pin **141** is disposed through cam profiles **137** and lift arms **129.** Cantilever pin **143** is disposed through cantilever arms **131** and lift arms **129** so as to pivotally connect cantilever arms **131** to lift arms **129.** Support pin **145** secures an end of cantilever arms **131** to base plate **116.** Actuator cable **134** is secured to lift pin **141.**

**[0071]** Actuator cable **133** can be operated by a take-up motor or manually, as described above with respect to the previous embodiments. In particular, retraction of actuator cable **133** causes lift pin **141** to slide along cam profiles **137**. As lift pin **141** slides along cam profiles **137,** lift arms **129** pivot about cantilever arms **131** and cantilever pin **143.** Sacral support member **14,** which is pivotally attached to lift arm **129** (to provide a tilt as described above), travels towards a user's sacral area, thereby providing increased sacral support as shown in Figures 24-25. To decrease the amount of sacral support, a user operates the take-up motor (or manual drive) let out actuator cable **133**. As actuator cable **133** is returned to a disengaged position, the rearward force provided by the seatback and the user's sacrum moves sacral support member **14,** lift arms **129,** and cantilever arms **131** into a disengaged position, as shown in Figures 22-23. Optionally, a spring return system can be included to assist in returning the sacral support member to a disengaged position. To add a spring return system, a pin **167** is inserted into holes **163**, and a spring is used to connected pin **167** and lift pin **141**, as shown in Figure 25.

**[0072]** Similarly, complementary support system 7 includes lift arms **127,** cantilever arms **125,** and complementary support actuator cable **134.** As illustrated in Figure 24, lift pin **151** is disposed through cam profiles **139** and lift arms **127.** Cantilever pin **153** is disposed through cantilever arms **125** and lift arms **127** so as to pivotally connect cantilever arms **125** to lift arms **127.** Support pin **155** secures an end of cantilever arms **125** to base plate **116.** Actuator cable **134** is secured to lift pin **141.**

**[0073]** Actuator cable **134** can be operated by a take-up motor or manually, as described above with respect to the previous embodiments. In particular, retraction of actuator cable **134** causes lift pin **151** to slide along cam profiles **139.** As lift pin **151** slides along cam profiles **139,** lift arms **127** pivot about cantilever arms **125** and cantilever pin **153.** Complementary support member **18,** which is pivotally attached to lift arm **127,** travels towards a user's thoracic-lumbar area, thereby providing increased support as shown in Figures 24-25. To decrease the amount of complementary support, a user operates a take-up motor (or manual drive) let out actuator cable **134.** As actuator cable **134** is returned to a disengaged position, the rearward force provided by the seatback and the user's thoracic-lumbar area moves complementary support **18,** lift arms **127,** and cantilever arms **125** into a disengaged position, as shown in Figures 22-23. Optionally, a spring return system can be included to assist in returning the complementary support member to a disengaged position. To add a spring return system, a pin **169** is inserted into holes **161,** and a spring is used to connected pin **169** and lift pin **151,** as shown in Figure 25.

**[0074]** Referring to Figure 22, when sacral support system **5** and complementary support system **7** are in a fully retracted position, sacral support member **14** and complementary support **18** are generally flush with support base **116. As** a result, the user experiences little or no sacral or complementary support from the sacral support member and the complementary support member.
As in the previous embodiments, the sacral support system can be provided as a stand-alone support system or in combination with the complementary support system. When the adjustable support system is provided with a sacral support system and a complementary system, the adjustable support system can be operated by a single motor **99.** For example, referring to Figure 26, actuator cable **24** controls actuator cables **133** and **134,** and in turn, sacral support system **5** and complementary support system **7**. Additionally, since actuator cables **133** and **134** are interconnected by lever **26,** the adjustable support system **10** of Figures 22-26 is controlled as described above with respect to Figures 1-6. That is, the ratio of sacral support to complementary support is adjustable by changing the position where the actuator cables are attached to lever **26**. Thus, the adjustable support system illustrated in Figures 22-26 can be configured so that the sacral support travels farther toward a user than the complementary support, thereby providing a greater level of specific support to a user's sacral-pelvic area. In addition, since the adjustable support system and the sacral support system are both secured to lever **26**, rearward pressure applied to the sacral support by a user's sacrum or an obstructive element is counterbalanced by rearward pressure applied to the complementary support by a user's thoracic-lumbar area.

**[0075]** The embodiments described above and shown herein are illustrative and not restrictive. The scope of the invention is indicated by the claims rather than by the foregoing description and attached drawings of individual embodiments. The invention may be embodied in other specific forms without departing from the spirit of the invention. For example, other support systems may be used with the present invention. In addition, the shape and construction of the load distribution material and associated structures could be varied while still achieving the preferred functionality. For example, a unitary structure may be used instead of a separate cushion, load distribution material, and sacral support member. Additional cushions and load distribution materials may be included between the sacral support member and the user in accordance with the principles discussed above. In another alternative, the cushioning and/or load distribution materials may have cut-out portions adapted to, for example, receive the sacral support member or the PSIS's of the ilias. In yet another alternative, the load distribution material may partially support or cover the PSIS's of the ilias. In still another embodiment, a load distribution material and/or cushioning could be omitted entirely. In another embodiment, a pair of supports corresponding to the PSIS's of the ilias can be selectively adjusted in a rearward direction, thereby creating a central sacral support area. Accordingly, these and other changes that come within the scope of the claims are intended to be embraced herein.

## Claims

1. A device for supporting a user's sacral anatomy while the user is wearing an obstructive element and is in a seated position, the device comprising:

    a seat having a seat back with a front portion, a rear portion and a frame, the front portion including a support cushion therebehind;
    a support member operably connected to the frame; and
    an adjustable sacral support member pivotally connected to the support member, the sacral support member operable to move toward and away from a rear surface of the front portion of the seat back.

2. The sacral support element of claim 1 wherein the sacral support member has a top portion with a greater horizontal width dimension than a bottom width dimension.

3. The sacral support element of claim 2 wherein the top portion has a horizontal width dimension of about 3.25 inches, and the bottom portion has a width dimension of about 2.6 inches.

4. The device of claim 1 further comprising:

    a second support member operably connected to the frame; and
    a complementary support member operably connected to the second support member.

5. The device of claim 4 wherein the complementary support member is configured to support one of the thoracic region of the spine of a user, the thoracic-lumbar region of the spine of a user, the lumbar region of the spine of a user, and the lumbar-sacral region of a user.

6. The device of claim 5, further comprising a load distribution material disposed between the support cushion and the complementary support member.

7. The device of claim 6, further comprising a load distribution material disposed between the support

cushion and the sacral support member.

**8.** The device claim 4 wherein the sacral support member is operably connected to the complementary support member.

**9.** The device of claim 8 further comprising an actuator operably connected to the sacral support member and the complementary support member, wherein the actuator is configured to control the position of the sacral support member and the complementary support member relative to the frame.

**10.** The device of claim 9 wherein the actuator includes at least one button.

**11.** The device of claim 9 wherein the actuator includes at least one wheel.

**12.** The device of claim 9 wherein the sacral support member is configured to extend a first maximum distance relative to the frame, and the complementary support member is configured to extend a second maximum distance relative to the frame, wherein the first maximum distance is greater than the second maximum distance.

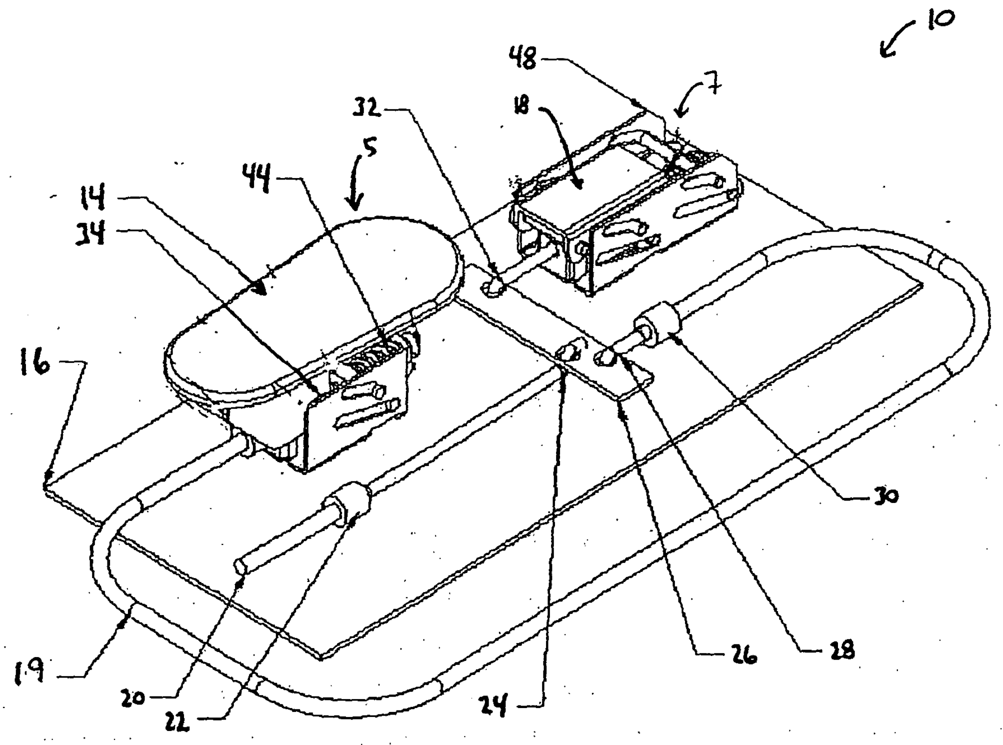
**13.** The device of claim 12 wherein the sacral support member is configured to tilt between 40 and 85 degrees relative to the frame.

**14.** The device of claim 13 wherein the sacral support member travels a distance of about 3 inches relative to the frame.

**15.** The device of claim 8 further comprising a cable suspension, wherein the sacral support member is operably connected to the complementary support member by the cable suspension.

**16.** The device of claim 1, further comprising a load distribution material disposed between the cushion and the front portion.

**17.** The device of claim 1, further comprising a load distribution material disposed between the cushion and the sacral support member.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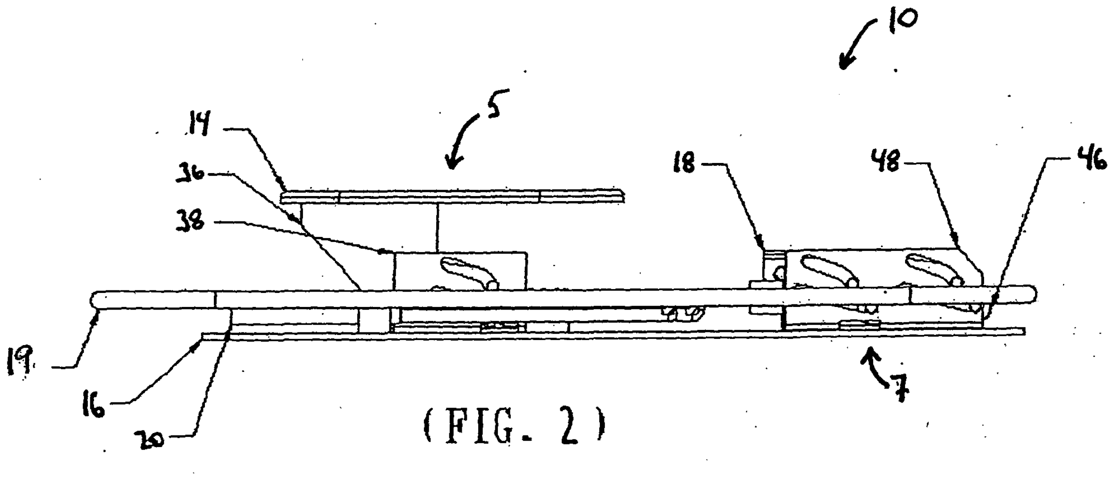
(FIG. 1)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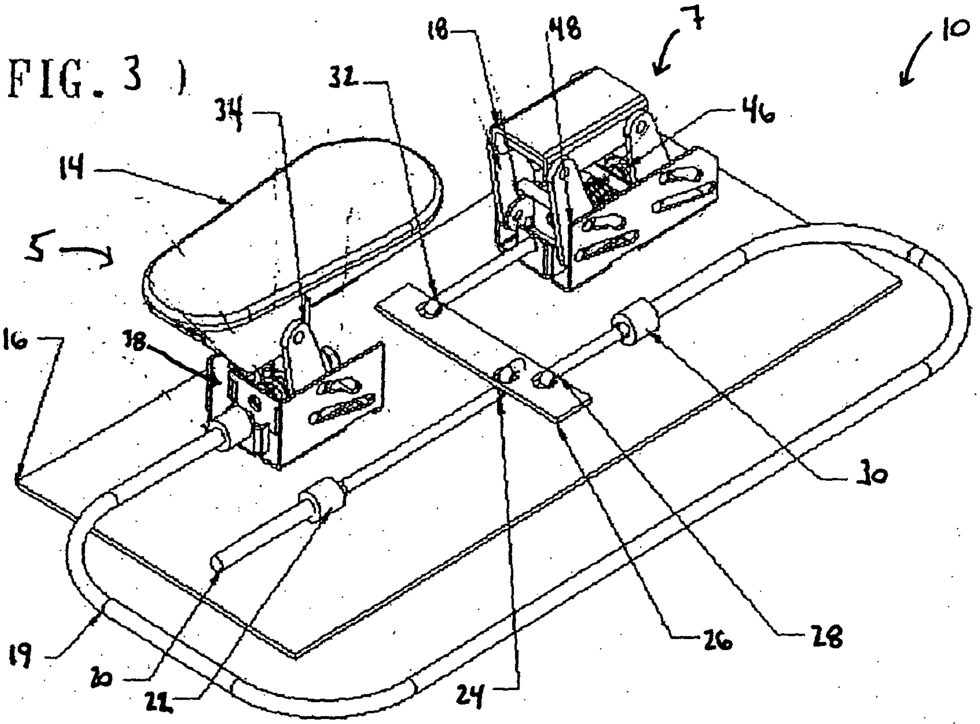
(FIG. 2)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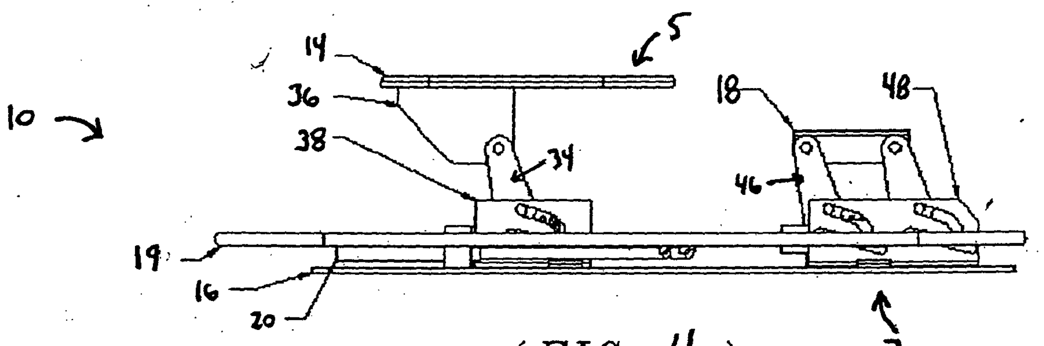
(FIG. 3)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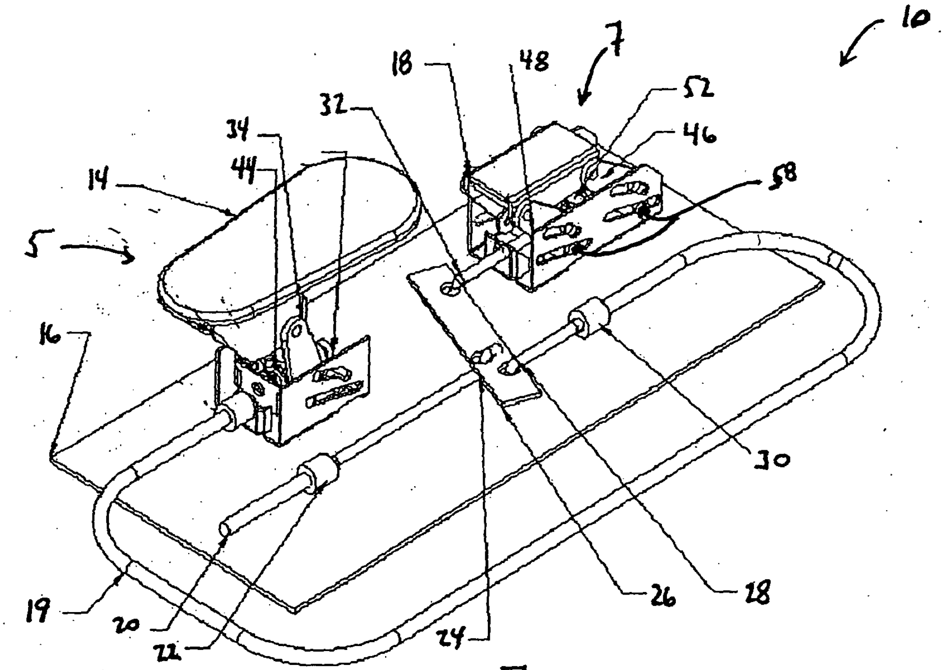
(FIG. 4)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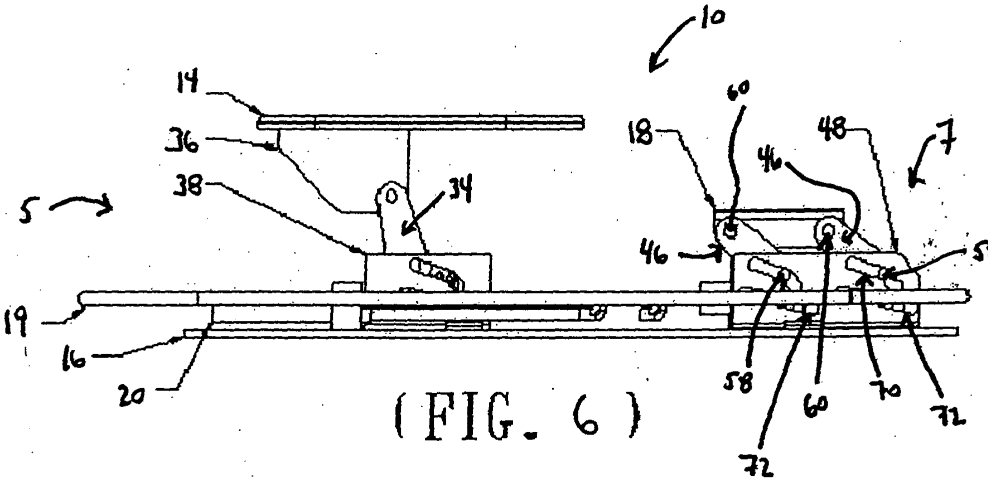
(FIG. 5)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(FIG. 6)

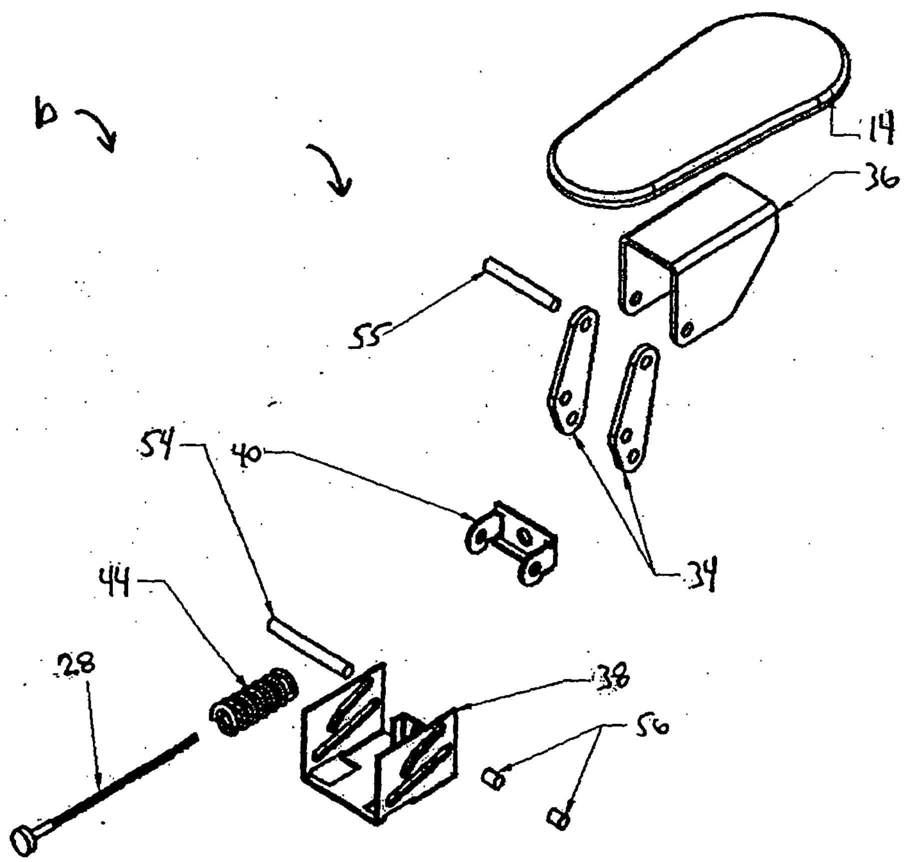



FIG. 7

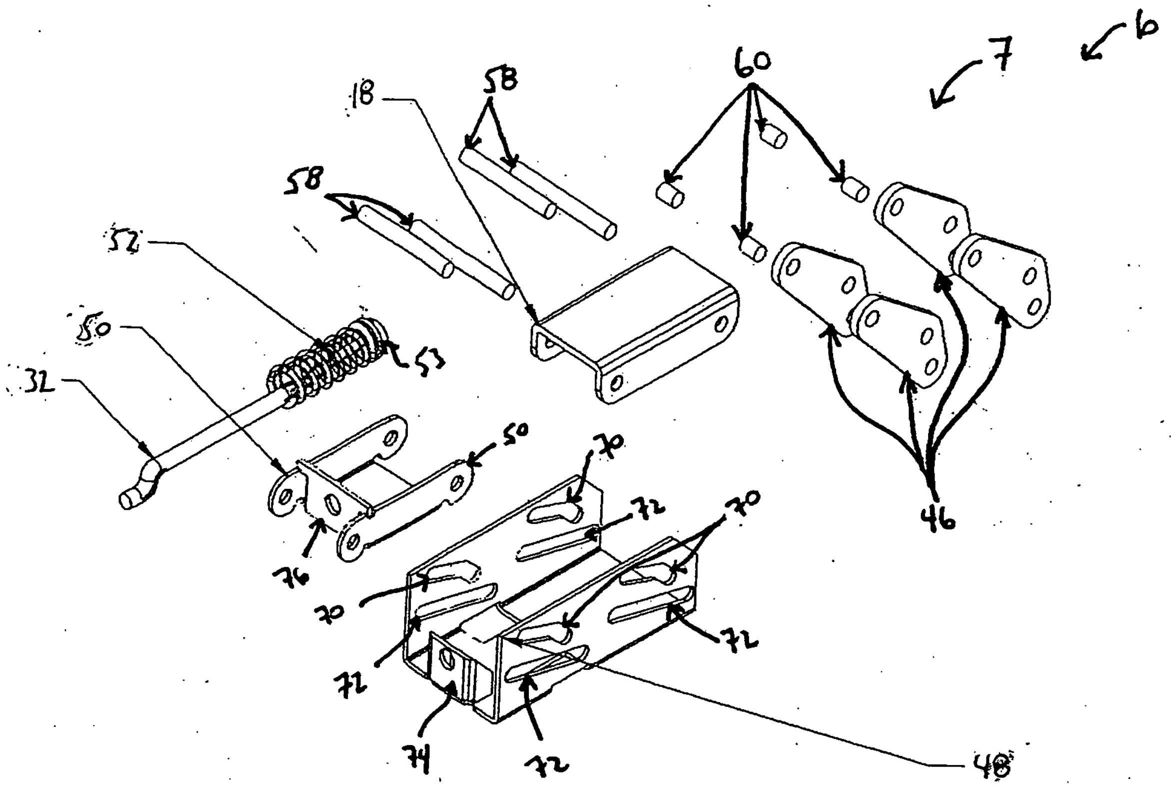
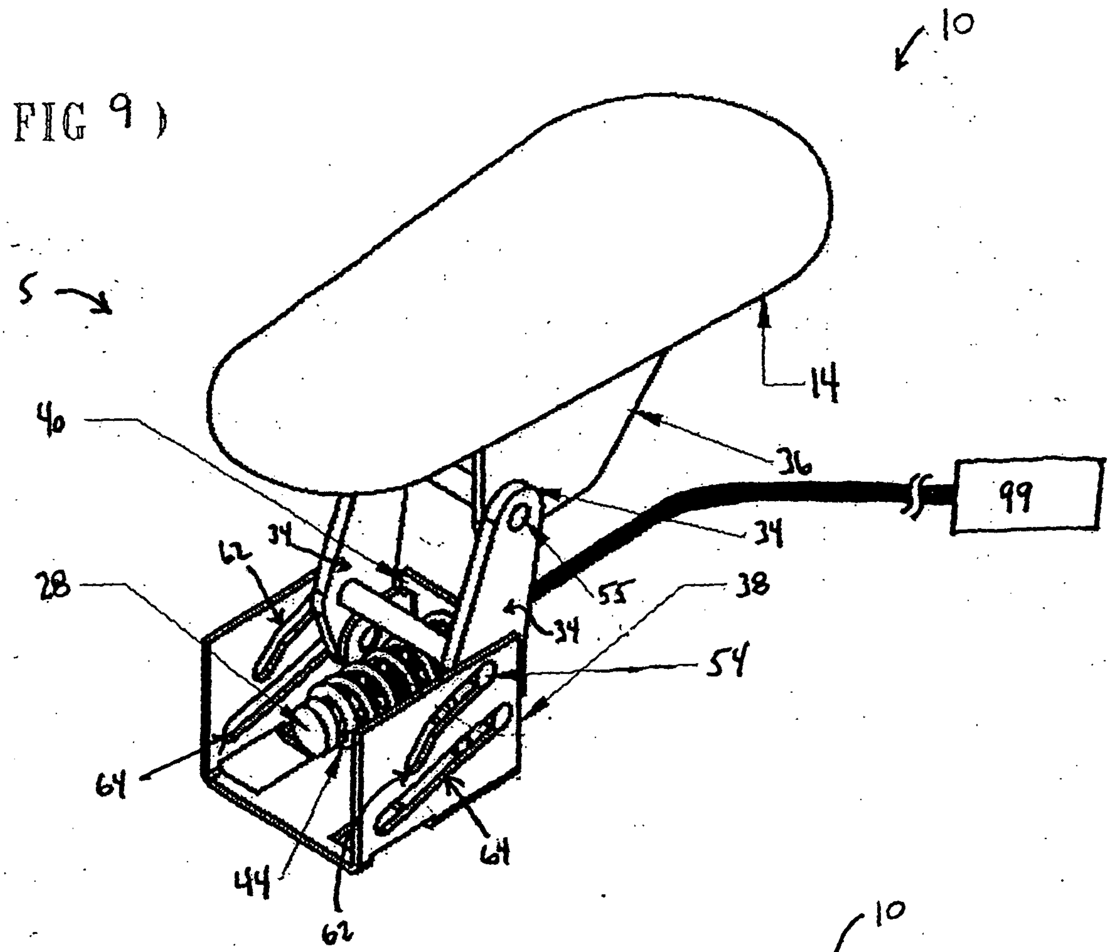



Fig. 8

(FIG 9)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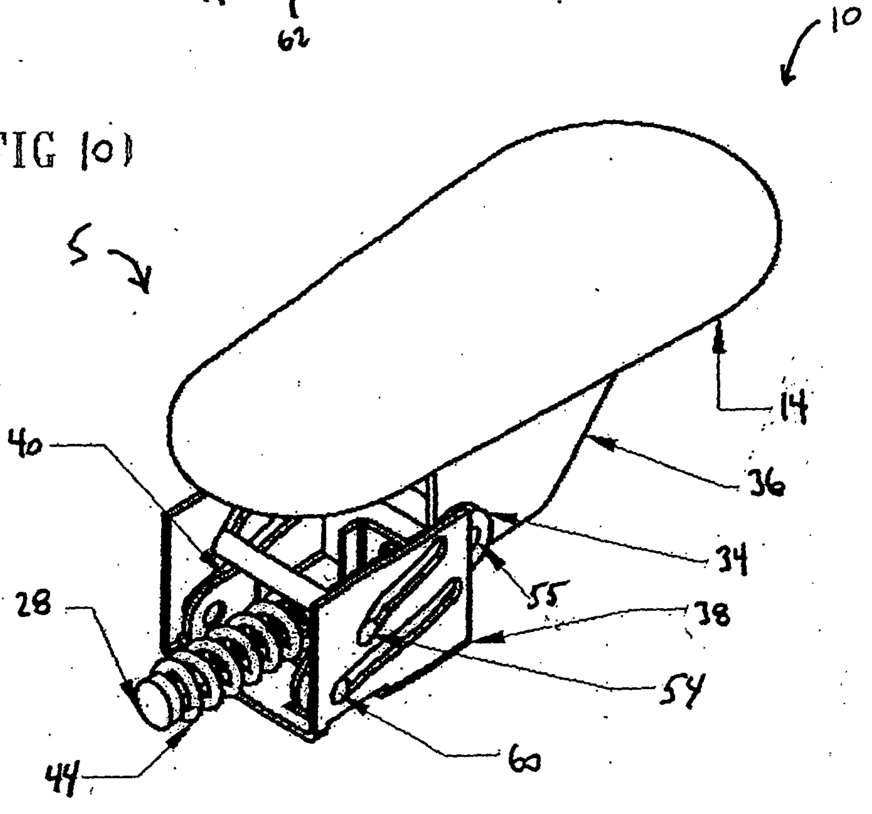
(FIG 10)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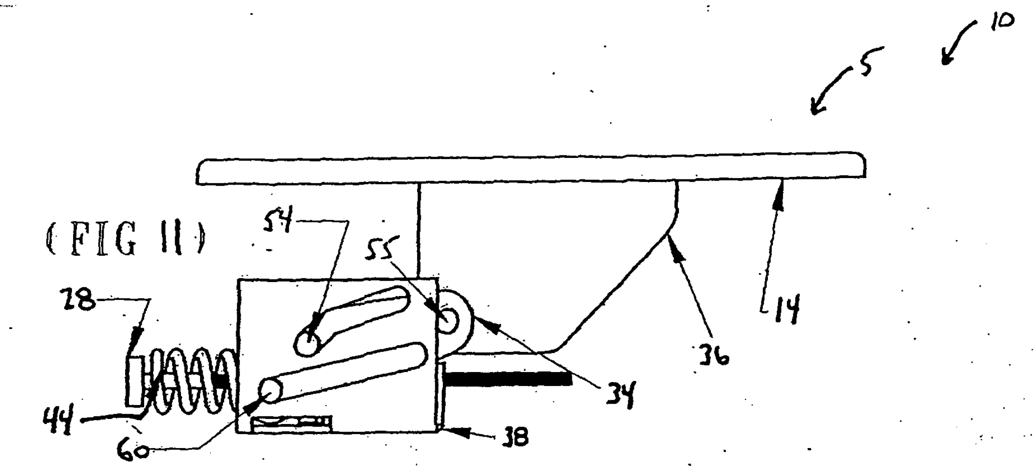
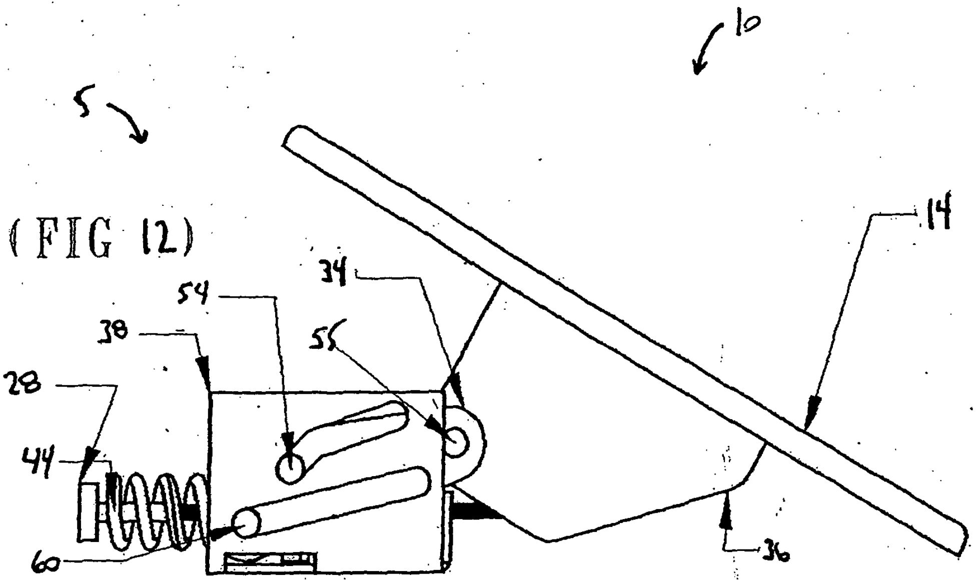
(FIG 11)




(FIG 12)



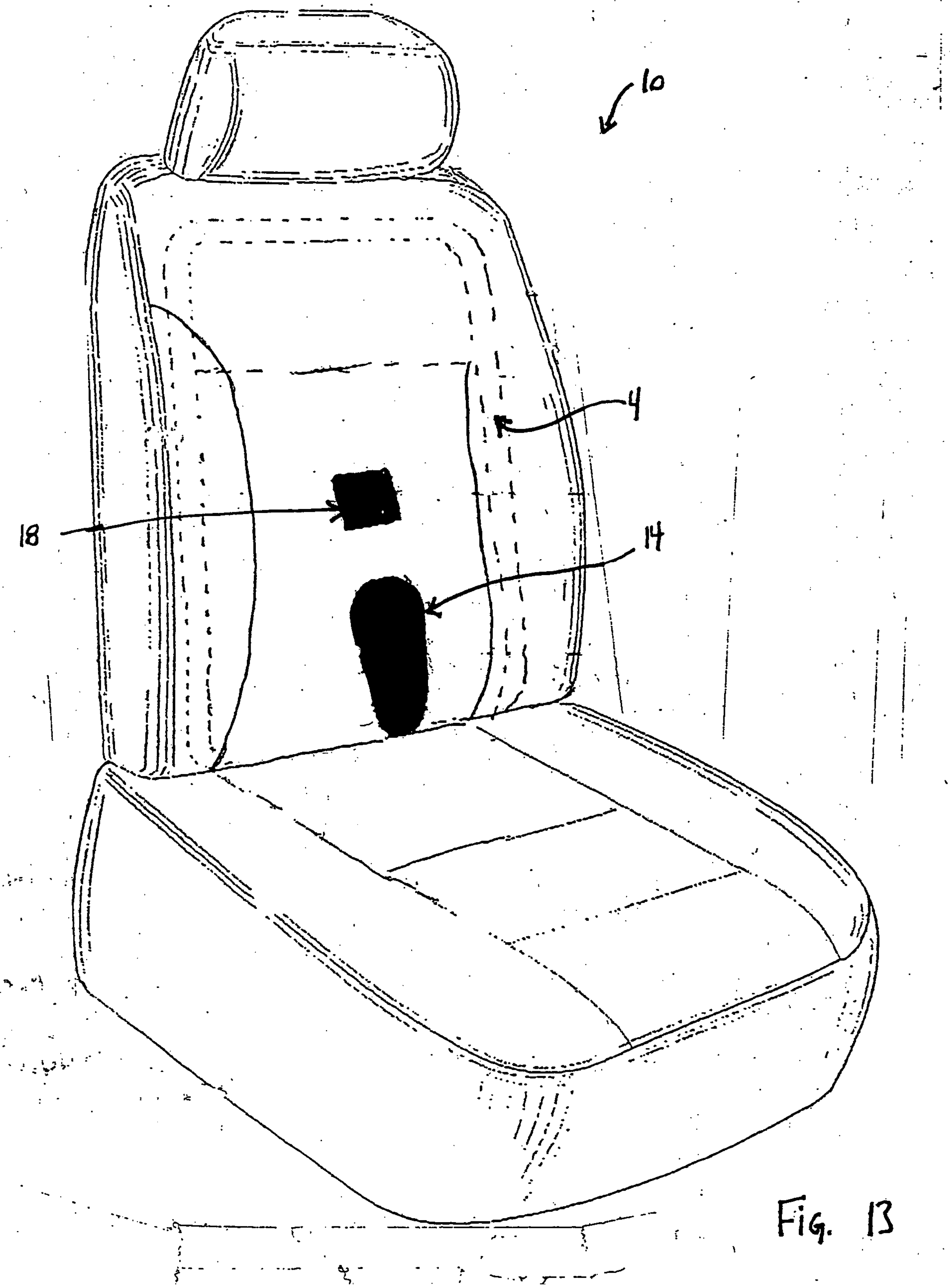



Fig. 13

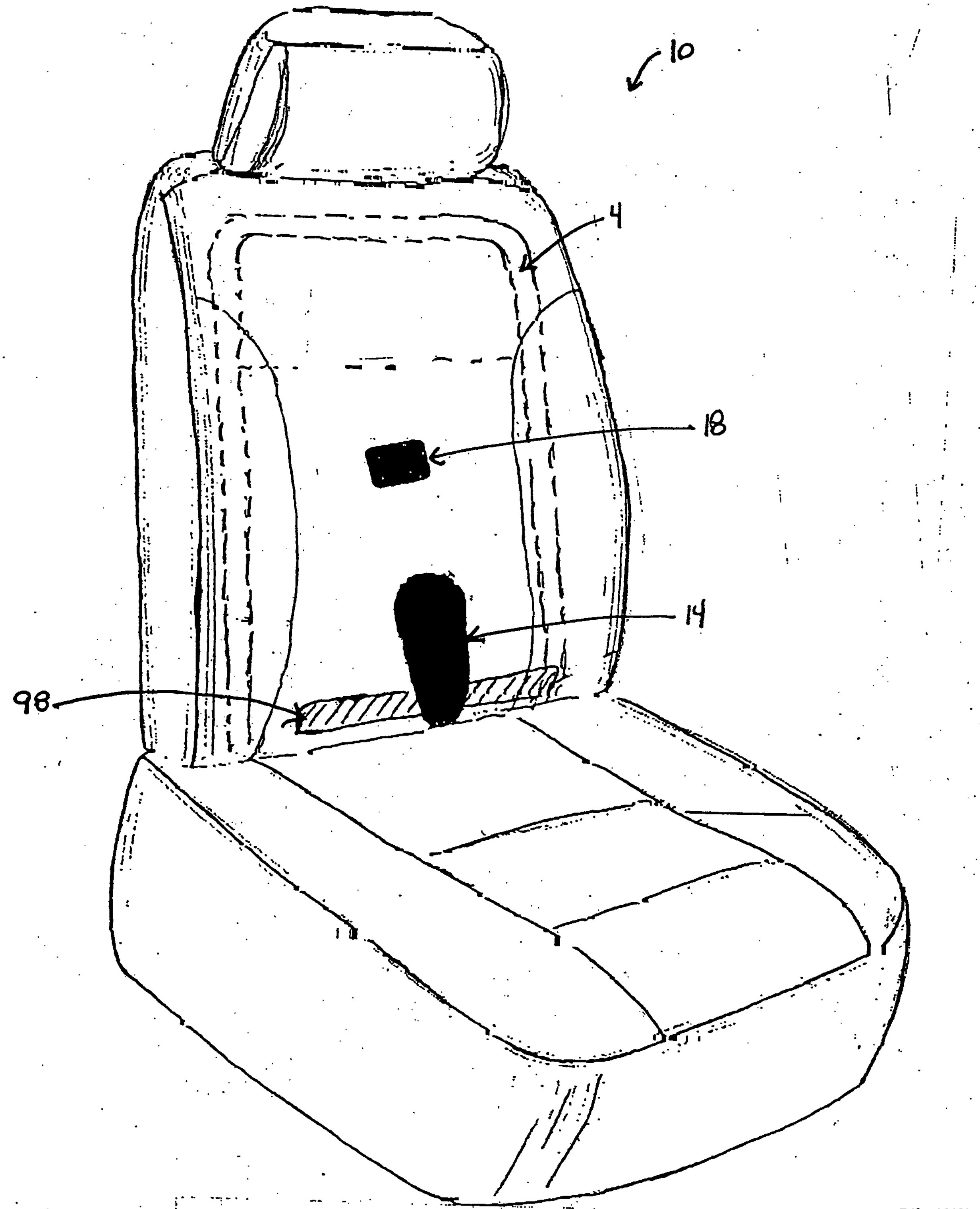



Fig. 14

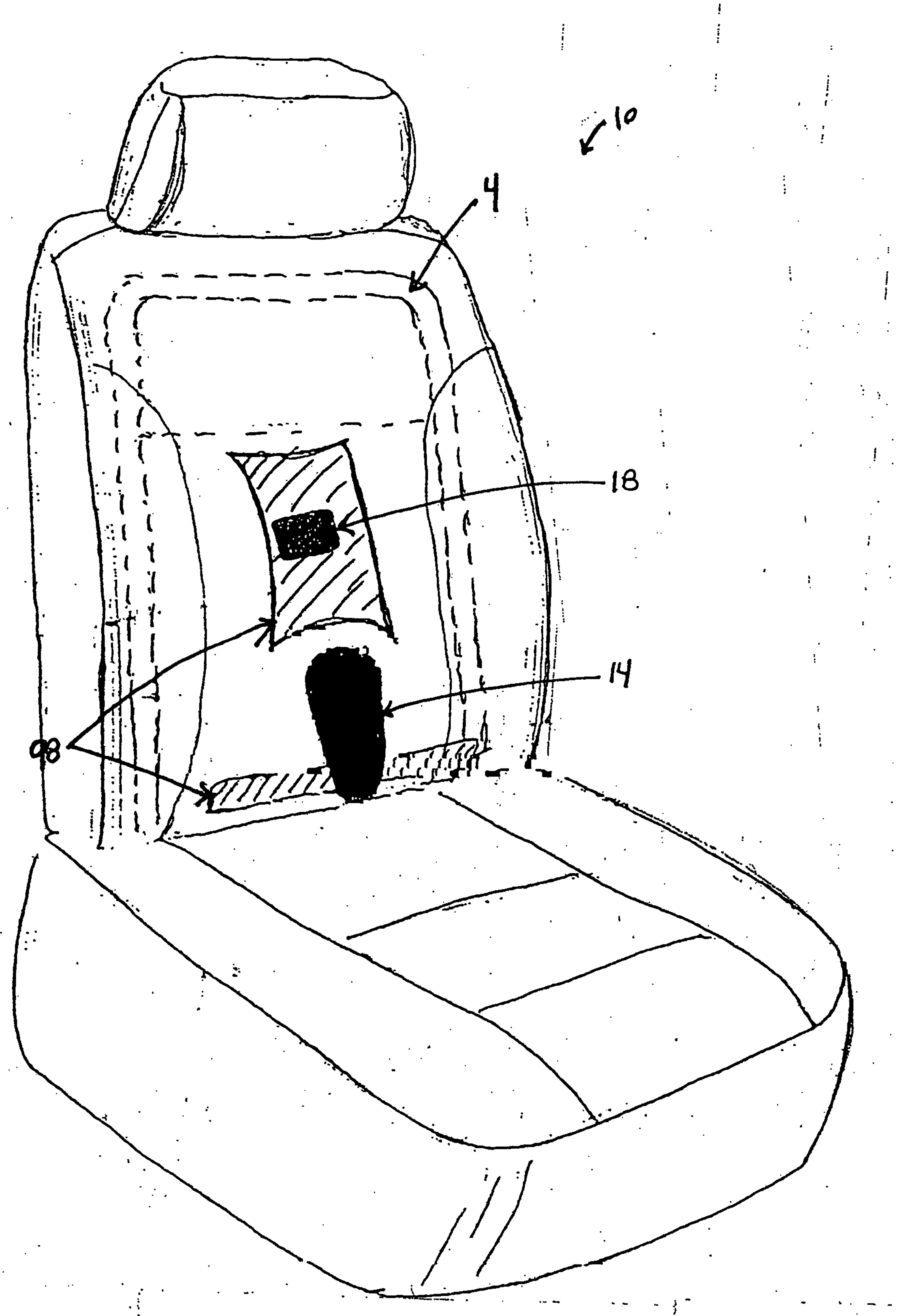
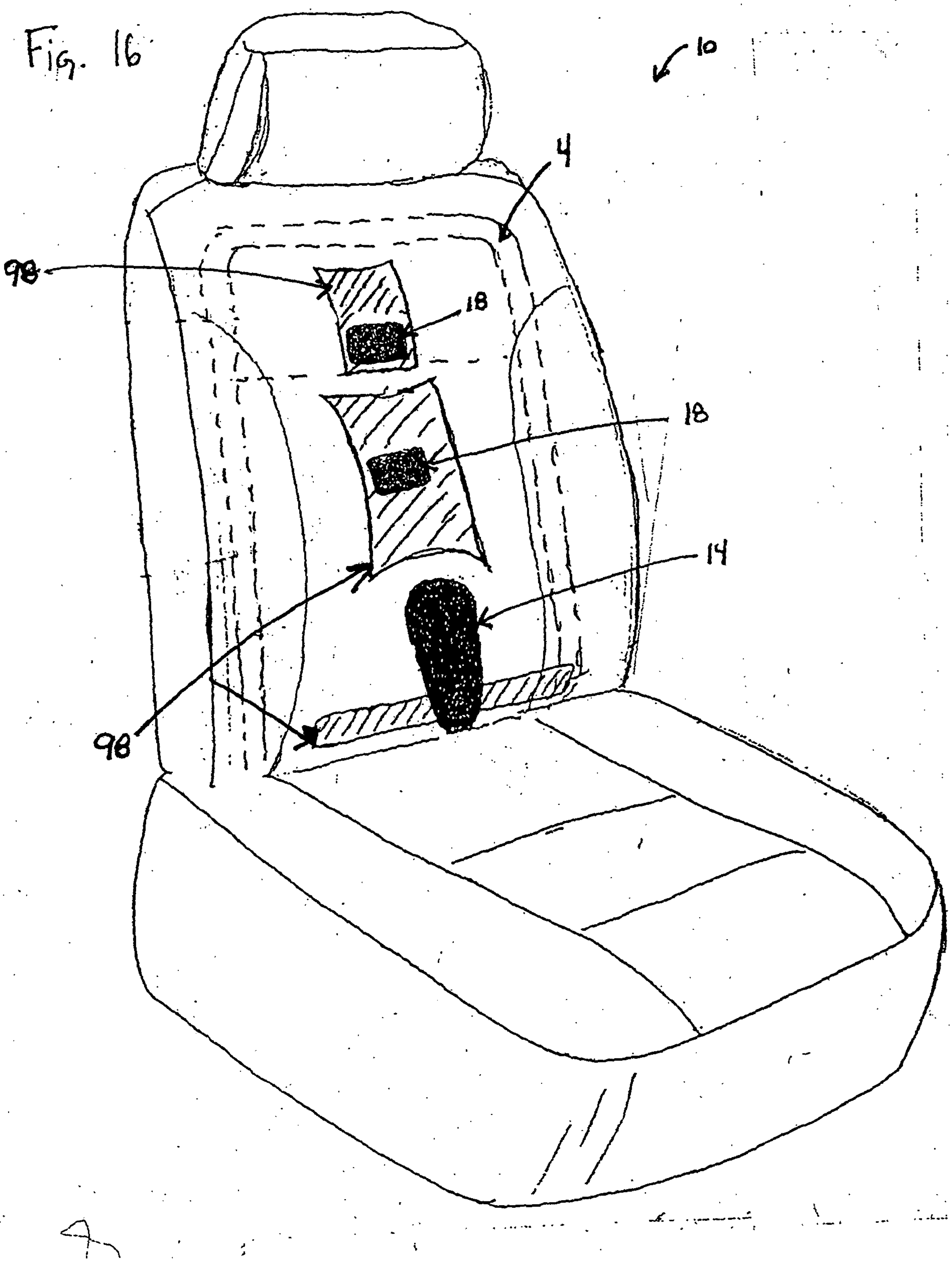



Fig. 15

Fig. 16



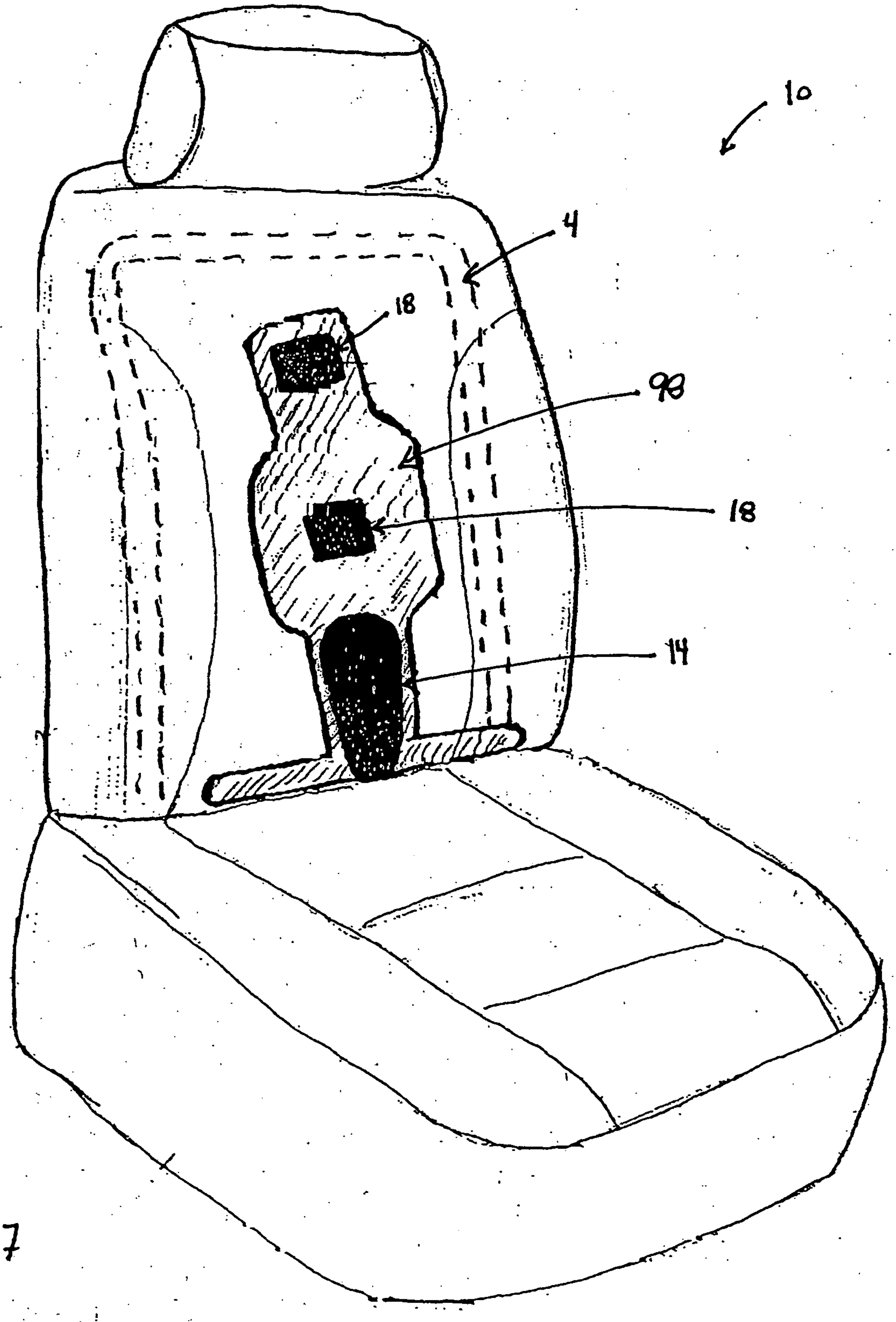



Fig. 17

FIG. 18

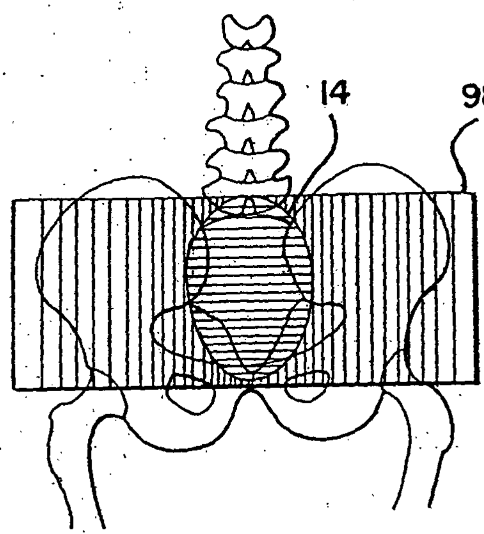



FIG. 19

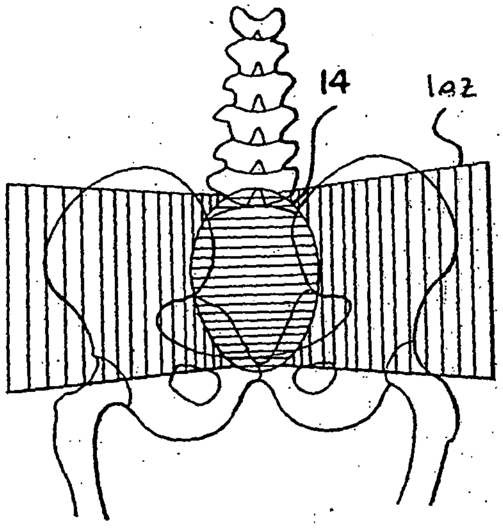



FIG. 20

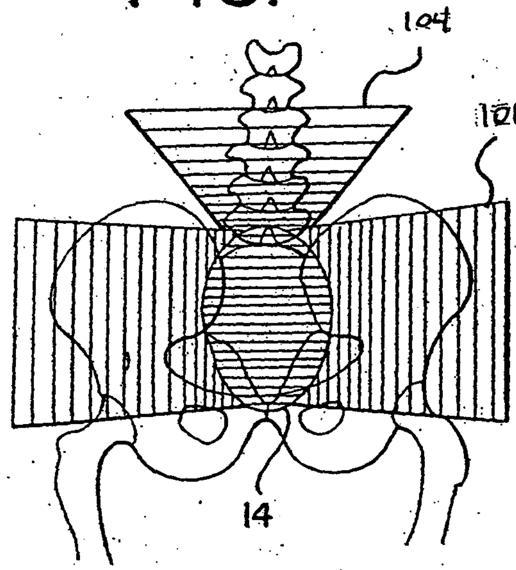



FIG. 21

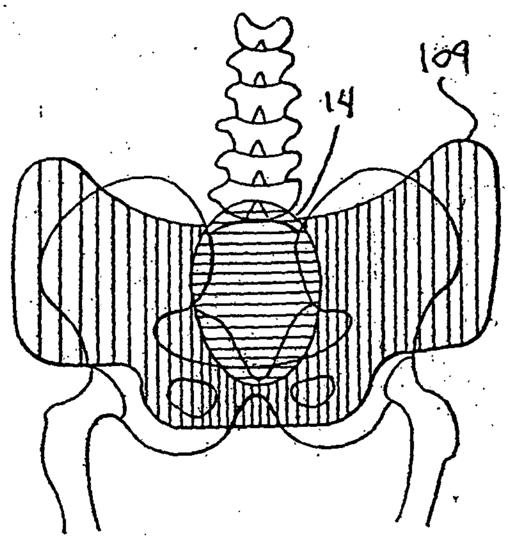
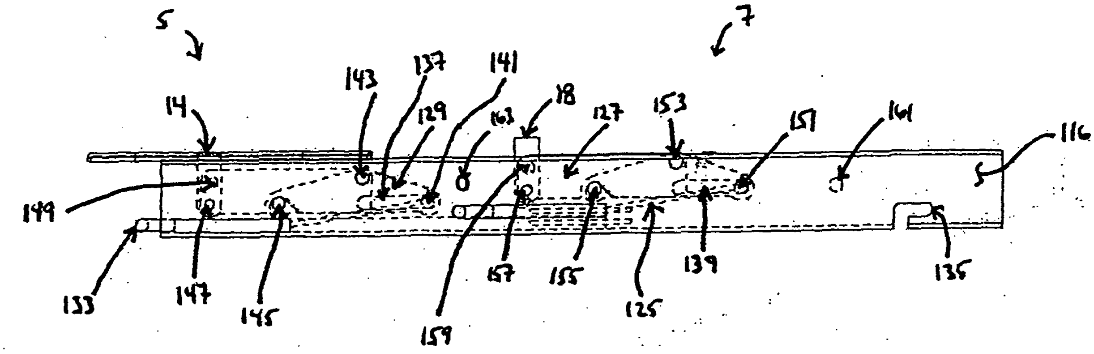


Fig. 22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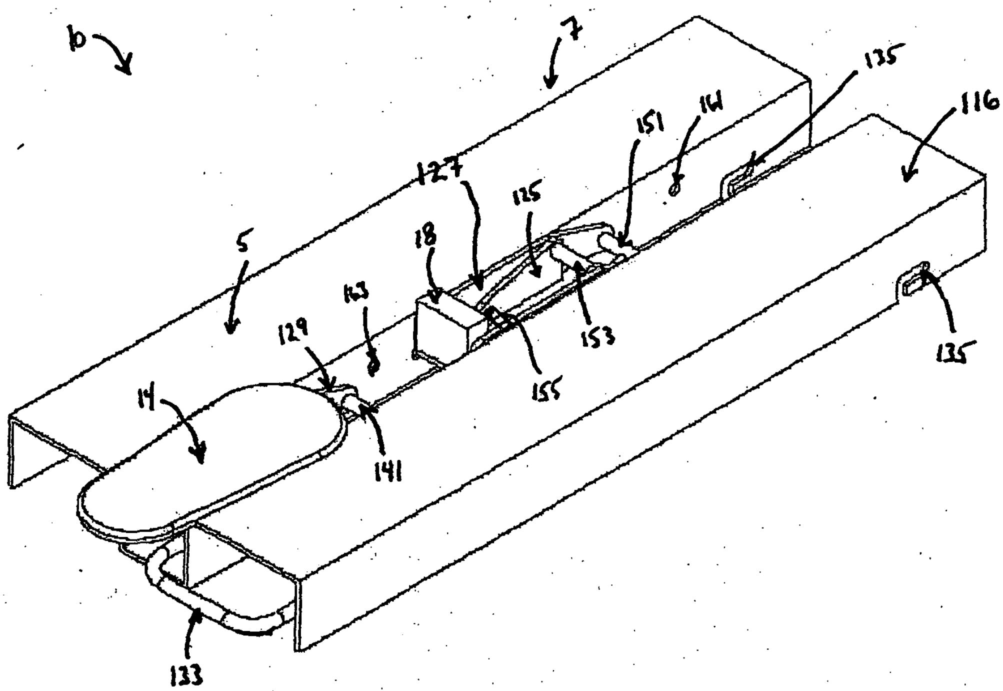
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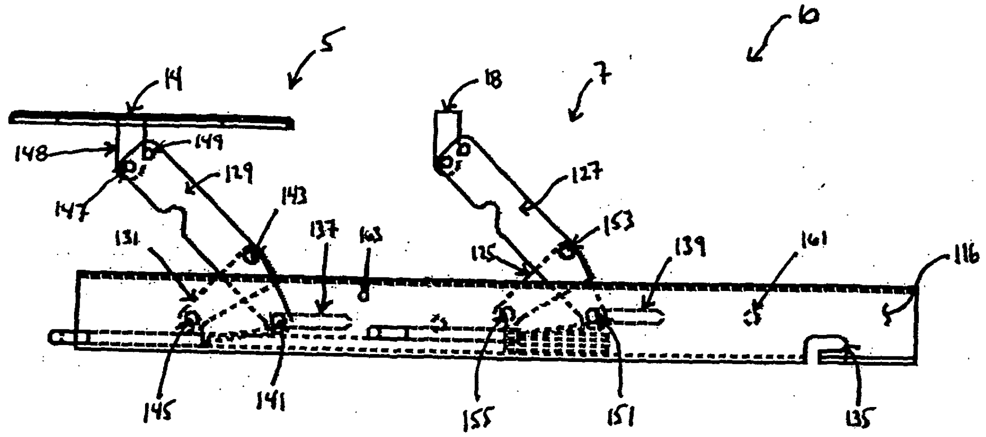
Fig. 23

Fig. 24



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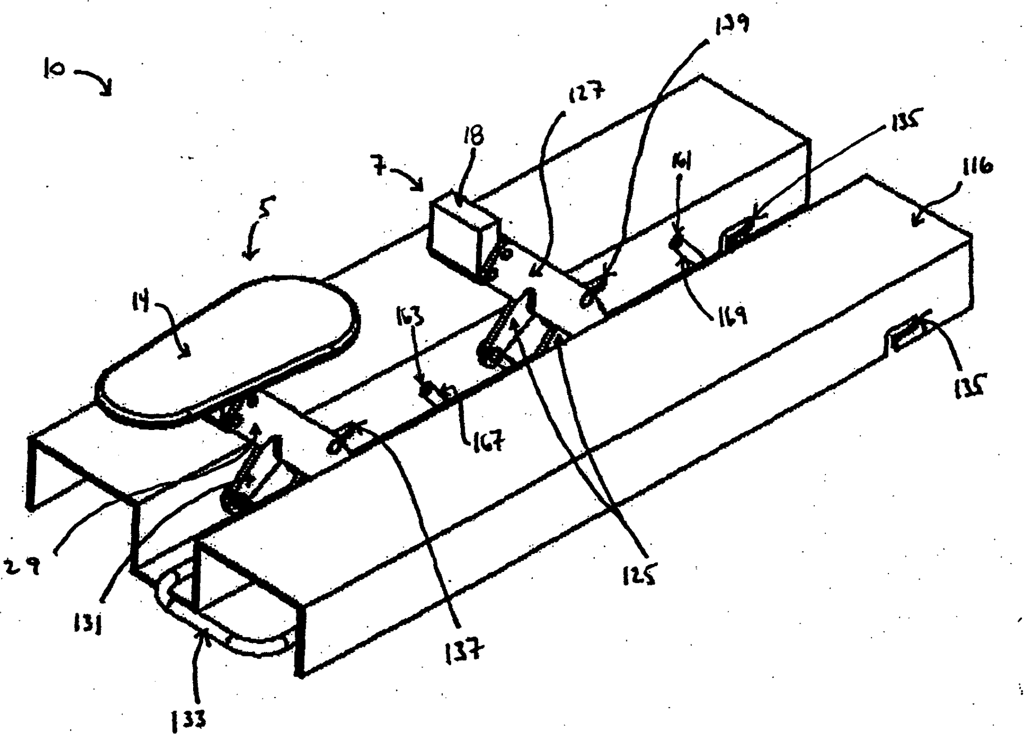

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Fig. 25

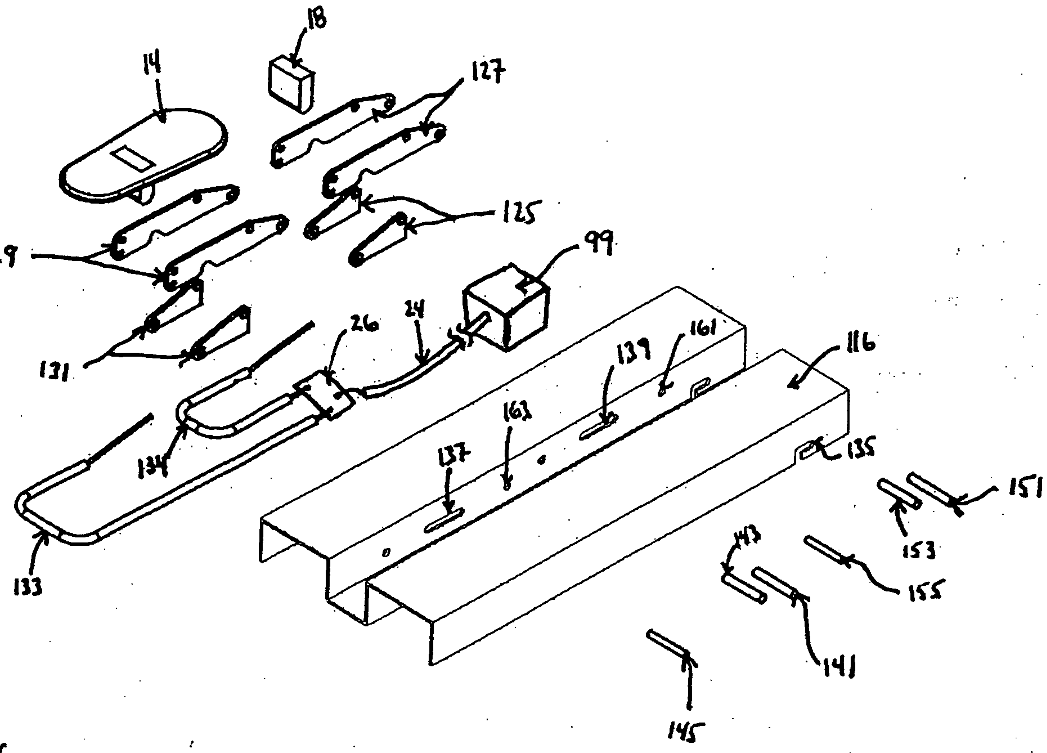
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Fig 26

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 05 01 3983

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| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int.Cl.7) |
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A47C

The present search report has been drawn up for all claims

1

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| The Hague | 24 October 2005 | VandeVondele, J |

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## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 05 01 3983

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24-10-2005

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